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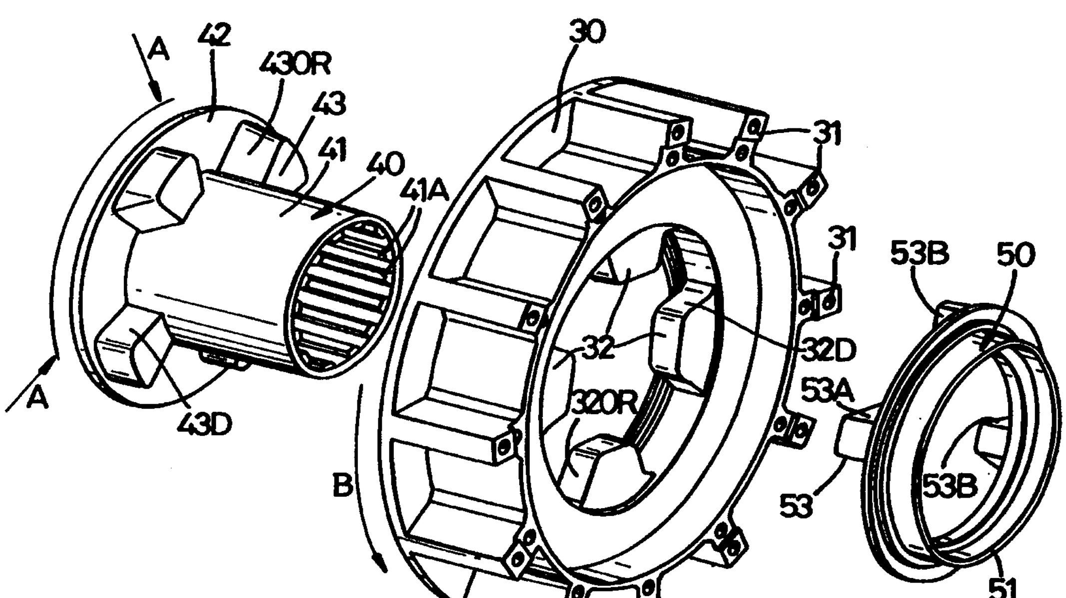
(54) Title: A FRICTION CLUTCH



(57) Abstract

A friction clutch for transmitting power under drive and over–run conditions which includes a hub (20) having a first rotationally fast part (30) with one or more friction surfaces (18) of the clutch, a second part (40) rotationally fast with a power shaft (19) and a third part (50) acted upon by the first and second parts which moves axially under the action of ramps (430R, 53A) to automatically partially disengage the clutch during transmission of power in at least one of the drive and over–run conditions.

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A FRICTION CLUTCH

The present invention relates to friction clutches and in particular friction clutches for motorcycles.

Considering a motorcycle application, such a friction clutch must have a torque capacity which is capable of transmitting at least the maximum engine torque seen at the input to the clutch as generated by the engine and often particular clutches installations have a much higher torque capacity. Furthermore the torque capacity of the friction clutch in the drive condition (i.e. when the engine is driving the transmission) is the same as the torque capacity in the over-run condition (i.e. under conditions of "engine braking").

Under certain circumstances when changing down through the gear ratios of a gearbox the engine braking can be sufficiently severe to cause the rear wheel of a motorcycle to "lock" and skid relative to the road surface. This is a potentially hazardous situation especially if the motorcycle is negotiating a bend at the time. Under such circumstances it can be beneficial to reduce the maximum torque level the clutch in the over-run direction to prevent wheel locking.

Under certain other circumstances where it is required to accelerate the motor cycle from rest quickly, the clutch is initially disengaged and a gear ratio is then selected. The engine revs are then increased and the clutch is then engaged relatively quickly causing the engine speed to reduce and the motor cycle to accelerate. Thus under these circumstances it is possible to induce torques in the transmission system of the motorcycle which are higher than a corresponding torque when the engine is running at a steady state condition at its maximum torque level. This is because the torque in the transmission system comprises the torque produced by the engine and also an additional transient torque level produced by the inertia of the engine as it initially slows down. Under such circumstances it can be beneficial to reduce the maximum torque level the clutch can transmit in the drive direction.

Thus according to the present invention there is provided a friction clutch for transmitting power under drive and over-run conditions including a clutch hub comprising a first component rotationally fast with one or more friction surfaces of the clutch, a second component rotationally fast with a power shaft, and a third component acted upon by the first and second components which acts to automatically partially disengage the clutch during transmission of power in at least one of the drive or over-run conditions.

According to a further aspect of the present invention there is provided a friction clutch for transmitting power under drive and over-run conditions including a clutch hub comprising a first component rotationally fast with at least one friction surface of the clutch and a second component rotationally fast with a power shaft in which the clutch can be automatically partially disengaged during transmission of power under over-run conditions and in which the at least one friction surface comprises a carbon-carbon material.

The invention will now be described by way of example only with reference to the accompanying drawings in which:-

Figure 1 shows a cross section view of an embodiment of a clutch according to the present invention;

Figure 2 is an exploded isometric view of the clutch hub of figure 1;

Figure 3 is a schematic sectioned exploded developed view taken in the direction of arrows AA;

Figure 4 is a view similar to figure 3 of components of a second embodiment of a clutch according to the present invention;

Figure 5 is a view similar to figure 4 showing the components in a position whereby the associated clutch is partially disengaged;

Figure 6 is a view taken in the direction of arrow G of the third component of the second embodiment;

Figure 7 is a view similar to figure 3 of components of a third embodiment of a clutch according to the present invention; and

Figure 8 is a cross-section view of a fourth embodiment of clutch according to the present invention.

With reference to figures 1 to 3 there is illustrated a single friction clutch 10 comprising a clutch cover 11 secured to a flywheel 12 by studs 13 and nuts 14. A belleville spring 15 reacts against the cover 11 and biases a pressure plate 16 towards a stack of interleaved drive plates 17 and driven plates 18. Drive plates 17 and driven plates 18 are made of "carbon-carbon" i.e. a carbon composite matrix filled with a carbon filler, and each have corresponding friction surfaces 17A and 18A respectively. Drive plates 17 are rotationally fast with flywheel 12, and driven plates 18 are rotationally fast with first part 30 of hub 20. Hub 20 further comprises a second part 40 and a third part 50. The first part 30 is generally annular in shape and includes

external projections 31 which engage in internal notches 18B of driven plates 18 and ensure that the driven plates remain rotationally fast with the first part 30 of the hub. First part 30 additionally has four radially inwardly projecting lugs 32 and an annular projection 35 with a circlip groove 36.

Second part 40 comprises a cylindrical internally splined portion 41 and a flange portion 42. The splines 41A of cylindrical portion 41 ensure that the second part 40 remains rotationally fast with shaft 19. Flange portion 42 additionally has four circumferentially spaced lugs 43.

Third part 50 is generally annular in shape and includes a cylindrical portion 51 used to mount a bearing 52 on its radially outer surface and also houses one end of spring 66 on a radially inner portion. Third party 50 additionally has four circumferentially spaced lugs 53 on a side remote from the cylindrical portion.

An outer periphery 44 of flange portion 42 is secured between a circlip 33 and a shoulder 34 of first part 30. Thus first part 30 and second part 40 are secured axially fast relative to each other. Second part 40 is secured axially fast on shaft 19 by nut 19A. Nut 19A also acts as an abutment for spring 66 which is installed in a pretensioned manner.

When assembled lugs 32 of first part 30 are situated circumferentially between lugs 43 of second part 40. Additionally each lug 53 of third part 50 is located circumferentially between adjacent lugs 32 and 43 (see Figure 3).

Disengagement means 60 comprises pivot plate 61, circlip 62, adaptor cage 63 and release bearing 64. The clutch can be disengaged at any time at the option of an associated operator (eg rider in the case of a motor cycle) by moving push rod 67 and associated push rod abutment 68 to the right as shown in figure 1. This causes the disengagement means 60 to also move to the right and act and move the fingers 15A of belleville spring 15 thus releasing the clamp load and disengaging the clutch.

Operation of the clutch is as follows:-

The friction clutch 10 rotates in the direction of arrow B of Figure 2 when the associated engine is running. With the clutch engaged power can be transmitted under drive conditions from the flywheel 12 via the friction surfaces 17A and 18A of drive plates 17 and driven plates 18 to the first part 30 of hub 20. Power is then transferred via drive surfaces 32D of lugs 32 into drive surfaces 43D of lugs 43 and then via splines 41A into shaft 19.

It will be noted that drive surfaces 32D and 43D are perpendicular to an axial plane of the clutch, e.g. perpendicular to flange 42. Thus when drive surfaces 32D are transferring power to drive surfaces 43D there is no component of force tending to move the first part 30 axially relative to the second part 40.

Power can also be transferred under over-run conditions from shaft 19 to flywheel 12. Under these circumstances power is transferred from over-run surfaces 43OR of lugs 43 to surface 53A of lug 53. Power is then transferred from surface 53B of lug 53 to surfaces 32OR of lug 32.

It will be noted that surfaces 53B and 32OR are also perpendicular to an axial plane of the clutch. However surfaces 43OR and 53A are angled relative to an axial plane of the clutch at a ramp angle C. Thus as power is transferred under over-run conditions there is a component of force F acting on third part 50 in axial direction away from flywheel 12. This component of force tends to move third part 50 and bearing 52 towards and ultimately into contact with disengagement means 60. If the over-run torque is sufficiently high the movement of third part 50 is sufficient to cause release plate 60 to act on fingers 15A of belleville spring 15 and automatically reduce the clamp load and thus the torque capacity of the clutch. The clutch will be partially disengaged to such an extent that the torque capacity of the clutch falls to

below the over-run torque and the clutch starts to slip. Once this occurs the partially disengaged clutch can now no longer transmit the full over-run torque and thus the component of force F reduces. An equilibrium is automatically reached whereby the shaft 19 transfers sufficient over-run torque to axially move the third part 50 and cause some clutch slip but the third part 50 is not moved sufficiently far to fully disengage the clutch (since with a fully disengaged clutch no torque can be transferred and third part 50 would return to its original position).

By varying the ramp angle C the equilibrium position can be altered. For example, by reducing the angle C the component of force F for a particular drive torque would increase causing more axial movement of third part 50 and causing additional partial disengagement of the clutch, in other words by decreasing the angle C the clutch will tend to slip at a lower torque level when power is being transmitted under over-run conditions. Conversely by increasing the angle C the clutch will tend to slip at a higher torque level under over-run conditions.

It should be noted that when the clutch starts to slip the bearing outer race 52A will rotate at the same speed as drive plates 17 and in particular friction surfaces 17A but the bearing inner race will be rotating at a higher speed with friction surfaces 18A.

The advantage of a clutch that automatically slips in the over-run direction is that it reduces the engine braking effect and reduces the likelihood of a drive wheel "locking" and skidding relative to the road surface.

By varying the ramp angle C and spring rate of spring 66 the over-run release characteristics can be varied to suit a particular installation.

With reference to figures 4-6 there is illustrated first part 130, second part 140 and third part 150 which are components of a second embodiment of a clutch according to the present invention. Components which fulfil the same function as those in friction clutch 10 are labelled 100 greater. Note that in the second embodiment the second part 140 moves to the left when viewing figures 4 and 5 when the clutch is in an over-run condition.

In this embodiment the over-run surfaces 143OR of lugs 143 and surfaces 153A of lug 153 are separated by a ball-bearing 170. Furthermore, surface 153A comprises a ramped portion 154 and a further portion 155 which is parallel to surface 153B. Over-run surfaces 143OR similarly comprise a ramped portion 145 and a further portion 146 which is parallel to drive surface 143D. Thus is can be seen from figure 5 that once the ball-bearing 170 contacts further portions 146 and 155 no additional axial movement of third part 150 takes place since the power is now solely being transmitted through

surfaces which are perpendicular to the direction of power transmission. This embodiment is particularly advantageous under circumstances where the clutch is subject to a reverse torque spike such as when a motorcycle engine is being "push started" that is to say that the motorcycle is pushed along a road to gain inertia. This inertia is then transferred to the engine, to start the engine, by rapidly engaging the clutch. Without such further portions 146 and 155 there is a risk that third part 150 may become disengaged from the first and second parts 130 and 140.

With reference to figure 7 there is illustrated first, second and third parts 230, 240, and 250 of a third embodiment of a clutch according to the present invention. Components which fulfil the same function as those in friction clutch 10 are labelled 200 greater.

In this case lugs 243 have both a ramped over-run surface 243OR and also a ramped drive surface 243D.

Third component 250 includes a plurality of drive lugs 256 and a plurality of over-run lugs 257.

When torque is transmitted in the drive direction drive lugs 256 are squeezed between drive surfaces 232D and 243D on adjacent first and second

components causing the third component to move axially to partially disengage the clutch. When torque is transmitted in the over-run direction, over-run lugs 257 are squeezed between over-run surfaces 243OR and 232OR on first and second component respectively. Again causing the third component to move axially.

It will be noted that drive surface 243D is at a different angle to over-run surface 243OR. This results in the clutch becoming partially disengaged at different torques in the drive and over-run directions (in this case the clutch becomes partially disengaged at a lower torque in the over-run direction than in the drive direction).

Figure 8 shows a fourth embodiment of a clutch according to the present invention. Components which fulfil the same function as clutch 10 are labelled 300 greater.

Third component 350 is moved axially in a manner similar to the movement of third component 50 of clutch 10. However in clutch 310 the belleville spring 315 creates a clamp load that is reacted by arm 321 and flange portion 337 of first part 330. Arm 321 is connected to flange portion 337 by bolt 322 which is under tension. Thus, arm 321 bolt 322 and flange portion 337 of first part 330 are all stressed as a result of the clamp load

exerted by belleville screen 315. This arrangement means that third part 350 rotates with pivot plate 361, thus it is possible to have plain metal to metal contact between third part 350 and pivot plate 361. This reduces the need for any form of bearing such as an equivalent to bearing 52 of clutch 10.

The invention is applicable to further embodiments such as:-

a) single plate or multi-plate clutches;

b) push rod or pull rod operated clutches;

c) clutches with belleville springs in which the pivot on the pressure plate is at a radius greater than the pivot on the clutch cover;

d) clutches in which coil springs act to clamp the friction surfaces together, and

e) clutches in which the disengagement means does not rotate relative to the third part during clutch slip.

It can be particularly advantageous to use an automatically partially disengaging clutch in conjunction with a carbon-carbon clutch friction facings since the difference in clutch capacity in the drive direction between a cold clutch and a clutch at working temperature (hot) clutch can vary by a factor of 2 i.e. double. This is because the friction co-efficient of carbon-carbon material goes from say 0.25 cold to 0.5 hot. However for a typical application with an ramp angle C of 64 degrees, the slip torque in the over-run direction

is found to only vary by a factor of about 1.25 between a cold and hot clutch since the equilibrium position of the third part is based on torque levels and not friction co-efficient levels. Thus, the engine braking effect produced by say a motorcycle is more consistent and consistent motorcycle characteristics promote safety.

Furthermore, when designing for a specific installation, the torque capacity of a carbon-carbon clutch is based upon the maximum torque produced by the engine and the lowest co-efficient of friction for the drive and driven plates must be assumed (i.e. 0.25 with a cold clutch). This ensures that full engine torque can be transmitted through a cold clutch. However with a hot clutch the torque capacity doubles and the highest potential torque levels seen in the transmission are in an over-run condition e.g. when a driving wheel has gone over a bump in the road surface and subsequently lands again. Such high torque levels are capable of breaking various parts of the transmission or over-revving the engine. Thus a carbon-carbon clutch which automatically partially disengages in an over-run condition will reduce maximum torque levels in the transmission under over-run conditions and promote transmission and engine life.

When designing a clutch for a specific application which partially disengages in the drive direction it is preferable that the clutch does not slip

below the maximum torque level produced by the engine as seen at the clutch, thus allowing the maximum engine torque capacity to be utilised. Furthermore, in some cases it is preferable to put in a margin to allow for a reduction in clutch torque capacity with wear.

Thus under some circumstances the clutch torque capacity is 1.2 or 1.4 times the maximum engine torque capacity as seen at the clutch.

When designing a clutch for a specific application which partially disengages in the over-run direction, it is some time preferable to ensure that the clutch does not slip below a level such that the engine can be started through the clutch. Such circumstances arise when a vehicle is being push started or an engine starter motor operates through the clutch to start the engine.

CLAIMS

1. A friction clutch for transmitting power under drive and over-run conditions including a clutch hub comprising a first component rotationally fast with one or more friction surfaces of the clutch, a second component rotationally fast with a power shaft, and a third component acted upon by the first and second components which acts to automatically partially disengage the clutch during transmission of power in at least one of the drive and over-run conditions.

2. A clutch as defined in claim 1 in which the first component is axially fast relative to a friction surface of the clutch.

3. A friction clutch as defined in claims 1 or 2 in which the second component is axially fast relative to the power shaft.

4. A friction clutch as defined in any one of claims 1 to 3 in which the automatic partial disengagement of the clutch is only in an over-run condition.

5. A friction clutch as defined in any previous claim in which the third component moves axially to effect automatic partial disengagement of the clutch.

6. A friction clutch as defined in claim 5 in which the third component displaces disengagement means which partially disengage the clutch.

7. A clutch as defined in claim 6 in which when the clutch is partially disengaged by the third component the disengagement means rotates relative to the third component by an amount proportional to the slip in the clutch.

8. A clutch as defined in claim 7 in which a rotating element bearing acts between the third component and the disengagement means.

9. A friction clutch as defined in claims 5 to 8 in which axial movement of the third component is effected by ramps on at least one of the third component or the first and second component acting on the other of the third component or the first and second components.

10. A friction clutch as defined in claim 9 in which the third component and at least one of the first and second components have interacting ramps.

11. A friction clutch as defined in claim 10 in which the interacting ramps are separated by ball bearings.

12. A friction clutch as defined in any one of claims 9-11 in which axial movement of the third component is limited by portions on the ramps.

13. A friction clutch as defined in any preceding claim in which power is transmitted between the first and second components via the third component when the third component is acting to partially disengage the clutch.

14. A friction clutch as defined in any preceding claim in which power is transmitted independently of the third component when the third component is not acting to partially disengage the clutch.

15. A friction clutch as defined in any preceding claim in which the first component has a plurality of circumferentially spaced first lugs and the second component has a plurality of circumferentially spaced second lugs positioned circumferentially between the first lugs for the transmission of power.

16. A friction clutch as defined in claim 15 in which the third component has a plurality of circumferentially spaced third lugs positioned circumferentially between the first and second lugs and which co-operate therewith to effect an axial movement of the third component to partially disengage the clutch.

17. A friction clutch as defined in claim 16 in which the third lugs comprise a plurality of drive lugs and a plurality of over-run lugs.

18. A friction clutch as defined in any preceding claim in which the torque required to partially disengage the clutch in the drive direction is different from the torque required to partially disengage the clutch in the over-run direction.

19. A friction clutch as defined in any previous claim in which at least one friction surface comprises a carbon-carbon material.

20. A friction clutch for transmitting power under drive and over-run conditions including a clutch hub comprising a first component rotationally fast with at least one friction surface of the clutch and a second component rotationally fast with a power shaft in which the clutch is automatically partially disengaged during transmission of power in at least one of the drive or over-run conditions and in which at least one friction surface of the clutch comprises a carbon-carbon material.

21. A friction clutch as hereinbefore described with reference to and as shown in figures 1 to 3, or 4 to 6, or 7 or 8 of the accompanying drawings.

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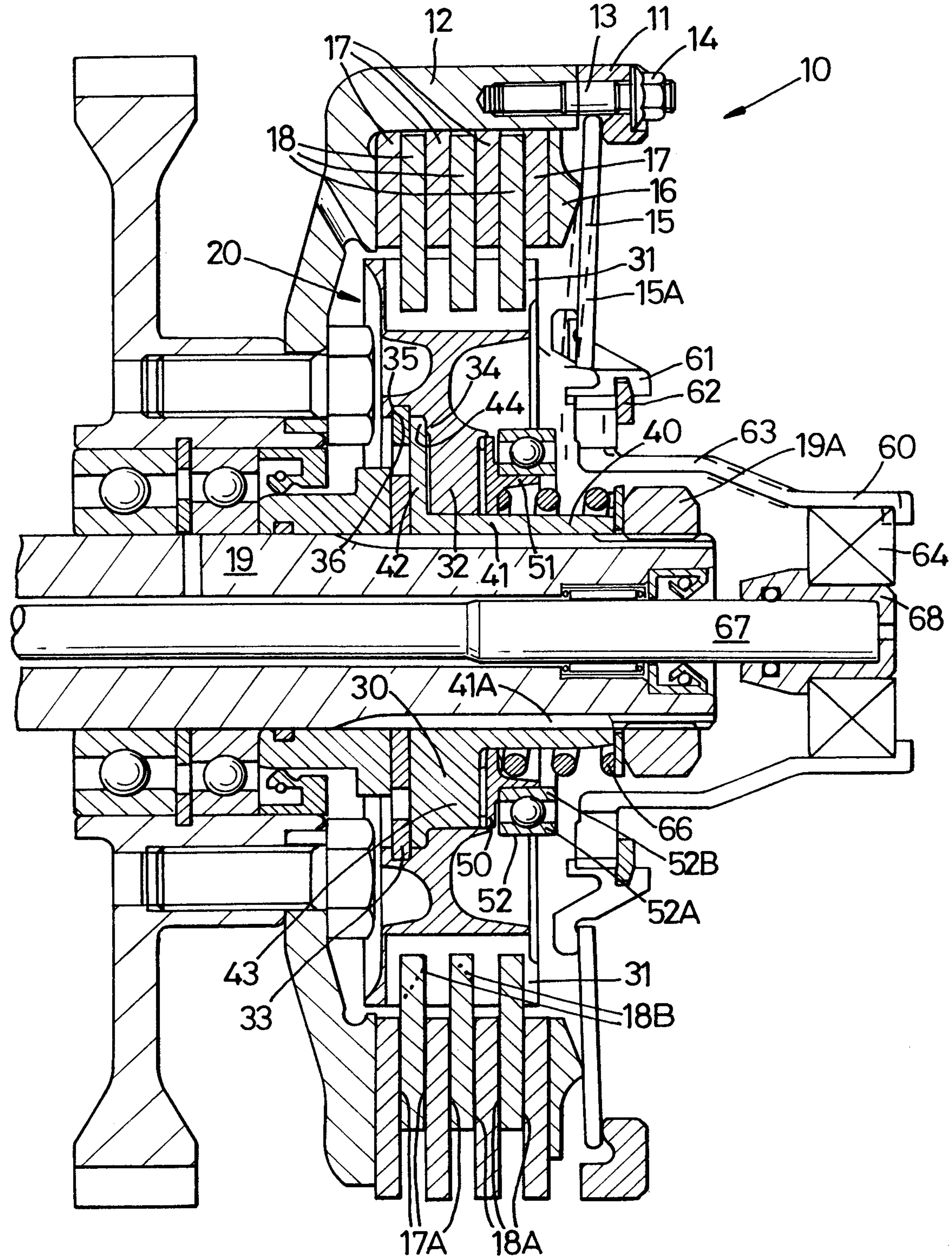
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Fig. 1

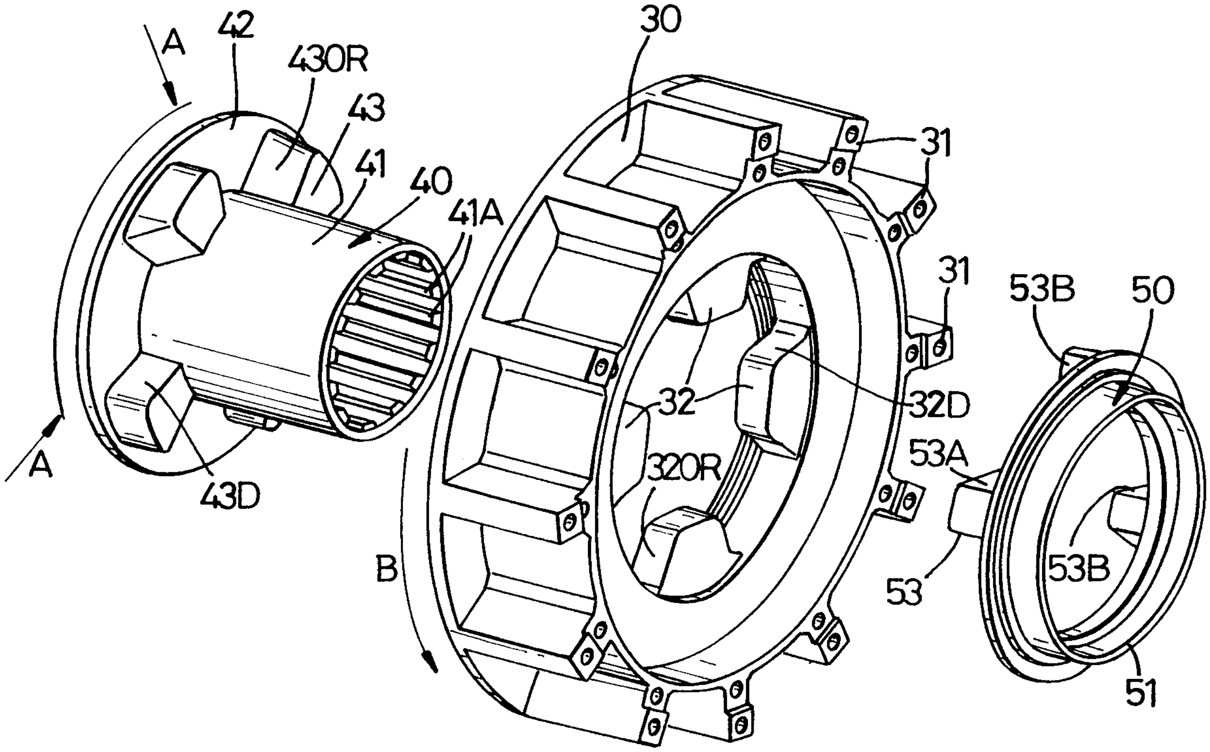
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Fig. 2

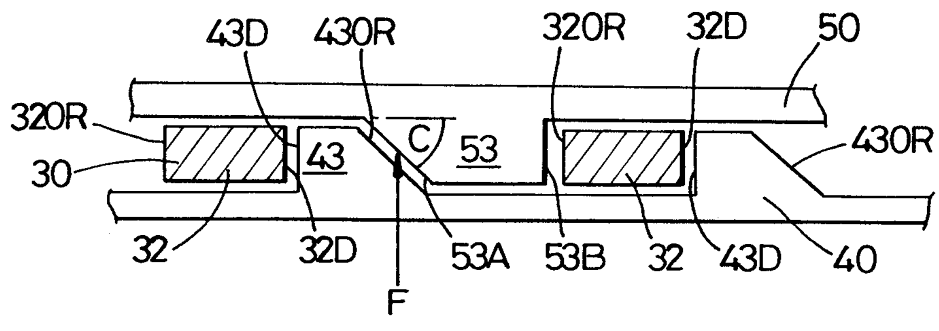
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Fig. 3

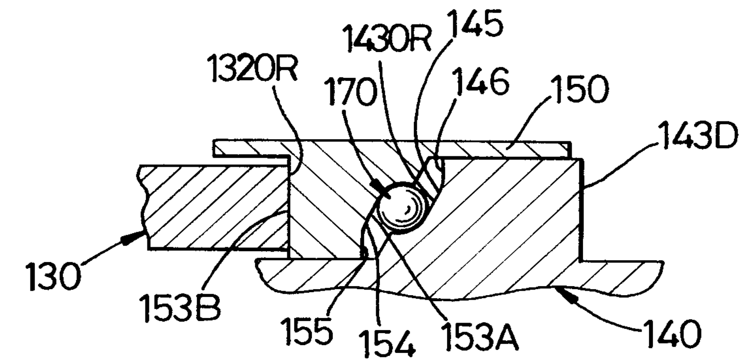

Fig. 4

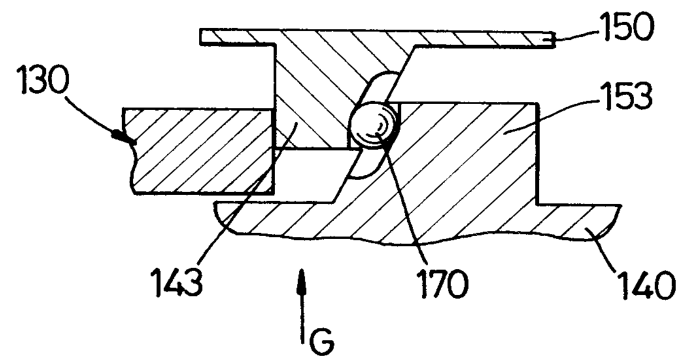

Fig. 5

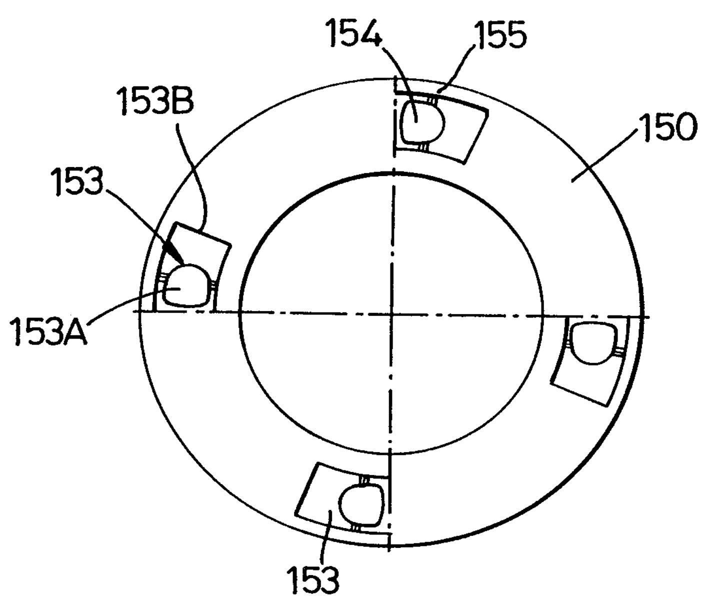

Fig. 6

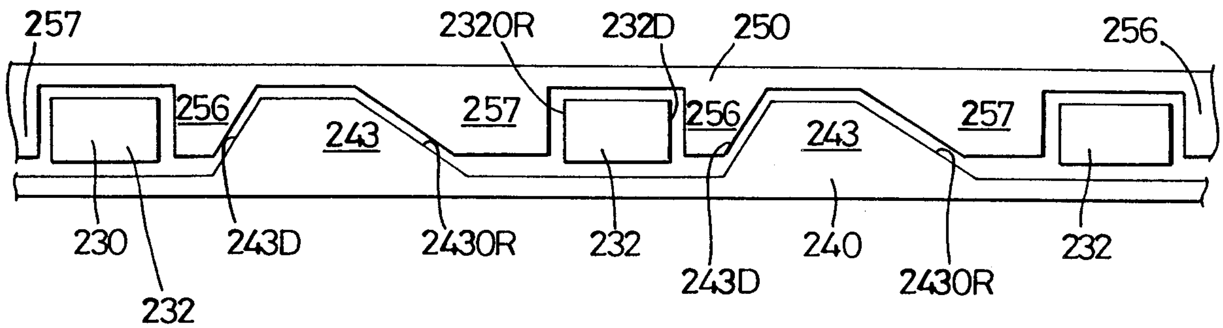
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Fig. 7

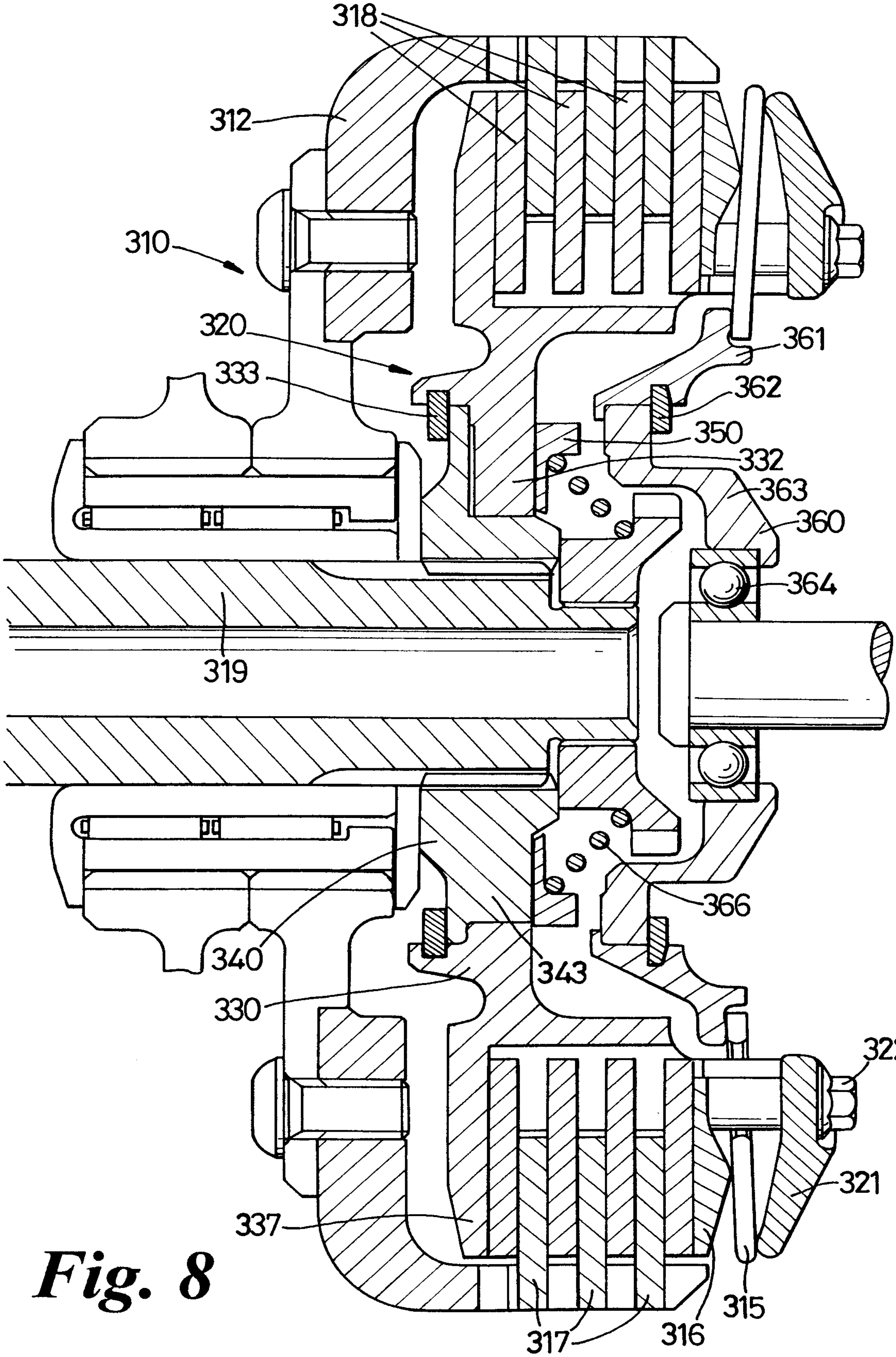
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Fig. 8

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 98/00721

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F16D43/21

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F16D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 52 755 B (SIEMENS-SCHUCKERTWERKE) 12 March 1959	1
Y	see column 3, line 9 - column 4, line 3; figures 1-3	2,3,11, 19,20
Y	FR 382 147 A (BADOIS) 30 January 1908 see page 1, line 39 - page 2, line 44; figures 1-3	2,3,11
Y	WO 93 22578 A (AUTOMOTIVE PRODUCTS) 11 November 1993 see page 6, paragraph 3; figure 2	19,20
Y	GB 940 357 A (FORD) 30 October 1963 see page 2, line 9 - page 3, line 61; figures 1-5	1-15, 18-20
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[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of theinternational search	Date of mailing of the international search report
16 June 1998	29/06/1998

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Form PCT/ISA/210 (second sheet) (July 1992)

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Int. .tional Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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International Application No
PCT/GB 98/00721

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DERWENT-ACC-NO: 1998-506817

DERWENT-WEEK: 200113

TITLE: Friction clutch particularly for motorcycles with partial automatic disengagement features to limit transmitted power

INVENTOR: CROWE S

PATENT-ASSIGNEE: AP RACING LTD[APRAN] , AUTOMOTIVE PROD PLC[AUTP]

PRIORITY-DATA: 1997GB-005111 (March 12, 1997)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE
WO 9840638 A1	September 17, 1998	EN
GB 2326684 A	December 30, 1998	EN
AU 9864090 A	September 29, 1998	EN
GB 2326684 B	February 28, 2001	EN

DESIGNATED-STATES: AL AM AT AU AZ BA BB BG BR BY CA CH CN CU CZ DE DK EE ES FI GB GE GH GM GW HU ID IL IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT UA UG US UZ VN YU Z W AT BE CH DE DK EA ES FI FR GB GH GM GR IE IT KE LS LU MC MW NL OA PT SD SE SZ UG ZW

APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
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INT-CL-CURRENT:

TYPE	IPC DATE
CIPS	F16D43/21 20060101

ABSTRACTED-PUB-NO: WO 9840638 A1

BASIC-ABSTRACT:

The friction clutch has a hub with a first component(30) rotationally fast with one or more friction surfaces of the clutch. A second component(40) is rotationally fast with a power shaft of the clutch. A third component(50) is acted upon by both first and second components.

The third part(50) can move axially under the action of ramps(430R,53A) at high torque levels. The ramps are angled relative to the axial plane of the clutch to generate a force acting to move said part(50). This axial movement acts to partially disengage the friction faces and hence limit the transmitted power.

USE - As a friction clutch for motorcycles.

ADVANTAGE - The clutch will automatically disengage partially to limit the torque transmitted to a preset level in both drive and over-run modes.

CHOSEN-DRAWING: Dwg.2/8

TITLE-TERMS: FRICTION CLUTCH MOTORCYCLE AUTOMATIC DISENGAGE FEATURE LIMIT TRANSMIT POWER

DERWENT-CLASS: Q63

SECONDARY-ACC-NO:

Non-CPI Secondary Accession Numbers: 1998-395018